Translation

PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference F0914PCT	**FOR FURTHER ACTION**	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)
International application No. PCT/JP03/09172	International filing date (*day/month/year*) 18.07.2003	Priority date (*day/month/year*)
International Patent Classification (IPC) or national classification and IPC C01B31/02		
Applicant AKAMATSU, Norio		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 10 sheets, including this cover sheet.

   ☐ This report is also accompanied by ANNEXES, i.e., sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

   These annexes consist of a total of _____ sheets.

3. This report contains indications relating to the following items:

   - I ☒ Basis of the report
   - II ☐ Priority
   - III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
   - IV ☒ Lack of unity of invention
   - V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
   - VI ☐ Certain documents cited
   - VII ☐ Certain defects in the international application
   - VIII ☒ Certain observations on the international application

Date of submission of the demand	Date of completion of this report
15.12.2004	14.07.2005
Name and mailing address of the IPEA/JP Facsimile No.	Authorized officer Telephone No.

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.
PCT/JP03/09972

I. Basis of the report

1. With regard to the **elements** of the international application:*

☒ the international application as originally filed

☒ the description:

pages _____, as originally filed
pages _____, filed with the demand
pages _____, filed with the letter of _____

☒ the claims:

pages _____, as originally filed
pages _____, as amended (together with any statement under Article 19
pages _____, filed with the demand
pages _____, filed with the letter of _____

☒ the drawings:

pages _____, as originally filed
pages _____, filed with the demand
pages _____, filed with the letter of _____

☐ the sequence listing part of the description:

pages _____, as originally filed
pages _____, filed with the demand
pages _____, filed with the letter of _____

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.
These elements were available or furnished to this Authority in the following language _____ which is:

☐ the language of a translation furnished for the purposes of international search (under Rule 23.1(b)).

☐ the language of publication of the international application (under Rule 48.3(b)).

☐ the language of the translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

☐ contained in the international application in written form.

☐ filed together with the international application in computer readable form.

☐ furnished subsequently to this Authority in written form.

☐ furnished subsequently to this Authority in computer readable form.

☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.

☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. ☐ The amendments have resulted in the cancellation of:

☐ the description, pages _____

☐ the claims, Nos. _____

☐ the drawings, sheets/fig _____

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).**

* *Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rule 70.16 and 70.17).*

** *Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.*

Supplemental Box
(To be used when the space in any of the preceding boxes is not sufficient)

Continuation of Box IV.3

The invention set forth in independent claim 1 and the invention set forth in independent claims 6-8 are not linked so as to form a single general inventive concept. That is to say, techniques for growing carbon nanotubes with an orientation that is substantially perpendicular to the growth substrate are already known in the prior art (for example, refer to documents 1-3 cited in Box V), and thus this feature cannot be said to be the special technical feature of the inventions set forth in the abovementioned claims. Such being the case, the special technical feature of the invention set forth in claim 1 is the feature of using an ionization means and an electric field generating means to grow oriented carbon nanotubes, whereas the special technical feature of the invention set forth in claims 6-8 is the feature of compounding the oriented carbon nanotubes and a metal substrate or metal layer.

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Claims	3-7, 9, 10	YES
	Claims	1, 2, 8	NO
Inventive step (IS)	Claims	3, 4, 6, 9	YES
	Claims	1, 2, 5, 7, 8, 10	NO
Industrial applicability (IA)	Claims	1-10	YES
	Claims		NO

2. Citations and explanations

Document 1: JP 2001-64775 A (Nippon Shinku Kabushiki Kaisha), 13 March 2001

Document 2: JP 10-203810 A (Canon Inc.), 04 August 1998

Document 3: JP 2003-147533 A (Gakko Hojin Kanyo Gakuin), 21 May 2003

Document 4: JP 2003-286017 A (Mitsubishi Gas Chemical Co., Inc.), 07 October 2003

Document 5: JP 2002-141633 A (Lucent Technologies Inc.), 17 May 2002

Document 6: US 6097138 A (Kabushiki Kaisha Toshiba), 01 August 2000

(1)

The invention as set forth in claims 1 and 2 lacks novelty in the light of document 3 cited in the international search report.

Document 3 discloses a microwave plasma-generating vapour deposition device wherein a substrate holder equipped with a heater for heating a substrate is used as one of the plasma electrodes and a grid electrode is disposed between the plasma electrodes, and also discloses a method for using said device to grow carbon nanotubes with an orientation that is substantially perpendicular to the substrate from a gas of a carbon-containing compound

(claims, paragraphs [0025] to [0029] and [0049], and fig. 1). Therein, the aforementioned plasma generation electrodes are considered to act as means for ionizing the carbon-containing compound, and to also act as electric field generating means. In addition, the aforementioned grid electrode increases the number of cations contributing to the growth of the carbon nanotubes, and thus is considered to act as a means for ionizing the carbon-containing compound. Furthermore, document 3 indicates that the substrate is configured from silicon, and that a catalytic film is provided on the surface thereof.

(2)

The invention as set forth in claim 1 lacks novelty in the light of document 2 cited in the international search report, and the invention as set forth in claim 2 does not involve an inventive step in the light of said document.

Document 2 discloses a device for growing carbon nanotubes by means of CVD, wherein a substrate mounted on a substrate holder equipped with a heater is used as a negative electrode for generating a direct current glow discharge and a positive electrode is disposed opposite thereto, and also discloses a method for using said device to grow carbon nanotubes with an orientation that is substantially perpendicular to the substrate from a gas of a carbon-containing compound (paragraphs [0065] to [0067] and [0071] to [0072], and fig. 4). Therein, the glow discharge generating electrodes are considered to act as means for ionizing the carbon-containing compound, and to also act as electric field generating means. In addition, silicon substrates provided with a catalytic film are conventionally used as substrates for growing carbon nanotubes by means of CVD, and thus this feature cannot be

found to be significant.

(3)

The invention as set forth in claims 1 and 2 does not involve an inventive step in the light of document 1 cited in the international search report. Document 1 discloses a device for growing a thin film of carbon nanotubes which is equipped with a microwave generation system for generating plasma, wherein a substrate holder and an electrode disposed so as to face the substrate holder are connected to a biasing power source, and also discloses a method for using said device to grow carbon nanotubes with an orientation that is substantially perpendicular to the substrate from methane (claims, paragraph [0015]). Therein, the aforementioned microwave generation system is considered to act as an ionization means, while the biasing power source together with the substrate holder and counter electrode connected thereto are considered to act as electric field generating means. In addition, although document 1 does not specifically mention a substrate heating means, it is common practice to provide a means for heating a substrate to a device for growing carbon nanotubes using plasma, as disclosed in documents 2 and 3 for example, and it is conventional to use a silicon substrate provided with a catalytic film as a substrate for growing carbon nanotubes by means of CVD. Consequently, these features cannot be considered to be significant.

(4)

The invention as set forth in claim 8 lacks novelty in the light of documents 4 and 5 cited in the international search report, and the invention as set forth in claim 10 does not involve an inventive step in the light of documents 1-5. Documents 4 and 5 describe

using vapor deposition to form a metal film on the surfaces of oriented carbon nanotubes grown upon a substrate equipped with a catalyst, and then heating and fusing said metal film and the metal layer of a substrate comprising a metal layer (the mounting substrate disclosed in document 4; the circuit layer or circuit substrate (10) disclosed in document 5) (refer to document 4, claims; and document 5, claims, paragraphs [0022] to [0024] and fig. 5). In addition, it is not found to be especially difficult to employ one of the growing methods disclosed in documents 1-3 when growing the oriented carbon nanotubes of the inventions disclosed in documents 4 and 5.

(5)

The invention as set forth in claims 5, 7 and 10 does not involve an inventive step in the light of documents 1-6. Documents 4 and 5 disclose the feature wherein oriented carbon nanotubes grown on a growth substrate equipped with a catalyst are transferred to a metal fixing layer (corresponding to the "metal substrate" in the invention of the present application). Therein, documents 4 and 5 indicate that the carbon nanotubes are affixed to the metal fixing layer via a metal layer formed on the surface of the carbon nanotubes by means of vapor deposition; however, the technique of transferring carbon nanotubes to a fixing material by melting the fixing material (synthetic resin layer (44)) itself and then introducing and affixing the carbon nanotubes directly into the molten material is well known, as disclosed in document 6 (column 8, line 65 to column 9, line 35 and fig. 6). Given that the metal is heated and melted during adhesion in the inventions disclosed in documents 4 and 5, a person skilled in the art could easily conceive of eliminating the vapor deposited metal layer, and instead

melting the metal fixing substrate itself and then introducing and affixing the carbon nanotubes therein after consideration of the disclosures in document 6. In addition, it is not found to be especially difficult to employ one of the growing methods disclosed in documents 1-3 when growing the oriented carbon nanotubes of the inventions disclosed in documents 4 and 5.

(6)

The invention as set forth in claims 3, 4, 6 and 9 involves an inventive step in relation to documents 1-6. Documents 1-6 do not disclose or suggest the invention as set forth in claims 3, 4, 6 and 9. However, the invention as set forth in claims 4 and 6 is unclear, and is not fully supported by the description, as is indicated in Box VIII.

VIII. Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:

(1)

With respect to the ionization means set forth in claims 1 and 2, the only ionization means supported by the description is a negative ion generator for imparting a negative charge to the vaporized gas; thus, other ionization means are not supported by the description.

(2)

Claims 1-3 do not specify the orientation of the electric field or the position of the substrate. However, pages 20-21 of the description indicate that the carbon nanotubes grow with a substantially perpendicular orientation because they have a positive charge and are drawn to the cathode side due to the influence of the electric field that flows from the anode to the cathode. Such being the case, both the orientation of the electric field and the point where the growth substrate comes into contact with the electrode are considered to be essential for growing with a substantially perpendicular orientation. As a result, claims 1 and 2, which do not delimit these features, cannot be said to fully disclose all of the features that are necessary for oriented growth.

(3)

With respect to the step for eliminating the growth film between the metal substrate and the carbon nanotubes in claims 4 and 6, page 21 of the description indicates that when eliminating the growth film, it is possible to maintain the oriented form of the carbon nanotubes and arrange the carbon nanotubes on the surface of the metal

VIII. Certain observations on the international application

substrate by gradually removing the growth film. However, claims 4 and 6 merely indicate that the growth film is eliminated, and do not disclose a growth film elimination step like that described on page 21. Normally, simply eliminating the growth film will cause the carbon nanotube film to become separated from the metal substrate, in which case it is not clear how the subsequent steps are to be carried out. Such being the case, the disclosures of claims 4 and 6 are unclear, and cannot be said to be fully supported by the description.

(4)

It is not clear what is being signified by the expression "growth film" in the disclosures of claims 4 and 6.

(5)

Page 11, lines 24-27 specifies fig. 18(g) to (i), but there are no corresponding figures (it is thought that this section should specify fig. 19(g) to (i)).